A Human Factors Investigation of Medication Alerts: Barriers to Prescriber Decision-Making and Clinical Workflow

Alissa L. Russ, PhD[1,2], Alan J. Zillich, PharmD[1-3], M. Sue McManus, NP[4], Bradley N. Doebbeling, MD, MSc[1,2,5], and Jason J. Saleem, PhD[1,2]

[1]VA HSR&D Center on Implementing Evidence-Based Practice (CIEBP), Roudebush VAMC, Indianapolis, IN; [2]Indiana University (IU) Center for Health Services & Outcomes Research, Regenstrief Institute, Inc., Indianapolis, IN; [3]Department of Pharmacy Practice, Purdue University School of Pharmacy, West Lafayette, IN; [4]Department of Nephrology, Roudebush VAMC, Indianapolis, IN; [5]Department of Medicine, IU School of Medicine, Indianapolis, IN.

Abstract

Computerized medication alerts (e.g., drug-drug interaction alerts), which are intended to protect patient safety, should also be designed to support prescriber workflow. However, relatively few studies have examined the use of medication alerts during patient care processes. To assess barriers associated with the use of medication alerts, we directly observed medication prescribing during routine patient care. Prescribers (physicians, pharmacists, and nurse practitioners) were recruited from five outpatient primary care clinics at a major Midwestern Veterans Affairs Medical Center (VAMC). A total of 199 alerts were observed across 91 patients and 20 prescribers during normal patient care tasks. Through inductive qualitative analysis, we identified 15 barriers associated with medication alerts; herein, we describe five of the key barriers in detail. Results may be used to create alert redesigns, which have the potential to more fully support clinical workflow, prescriber decision-making, and patient safety.

Introduction

Computerized medication alerts are one important aspect of computerized provider order entry (CPOE) that can potentially enhance clinical decision-making and prevent patient harm. For example, alerts can warn prescribers about potential drug-drug interactions, drug-allergy interactions, duplicate drug orders, etc, and lead to safety interventions before medications are dispensed. From a human factors perspective, alerts should effectively aid clinical workflow and prescriber decision-making in order to protect patient safety. Unfortunately, evidence suggests that medication alert systems may be inadequately designed to support prescribing processes.[1, 2] Perhaps the most common finding in the literature is that prescribers are overwhelmed by the number of medication alerts.[2, 3] Most of these alerts appear to be appropriately overridden, while key alerts that could result in actions to protect patient safety may be inadvertently overlooked.[2, 4] Relatively few studies have examined medication alerts in the context of routine patient care,[5] and it is unclear how these systems can be designed to more fully support routine medication ordering processes.

These types of medication alert issues have been reported for several healthcare organizations, including VAMCs.[2, 6, 7] Therefore, we observed and opportunistically interviewed outpatient primary care prescribers at a large VAMC to identify barriers to using medication alerts in the context of routine clinical care. Prescribers were observed as they ordered medications for patients and resolved any subsequent medication alerts. In the VA, these alerts appear in the Computerized Patient Record System (CPRS) as a pop-up window and require prescriber action to be resolved. An example alert pop-up is shown in Figure 1. A more detailed description of the VA's CPOE and alert system is reported elsewhere.[3] Here, we present findings that are part of a larger, on-going investigation of medication alerts. Results may be used to enhance the design of medication alerts in order to better support medication ordering processes.

Methods

Prescribers were observed and opportunistically interviewed as they ordered medications and resolved any subsequent medication alerts. We observed 20 prescribers across five outpatient primary care clinics at a major Midwestern VAMC, including 12 physicians, 4 nurse practitioners, and 4

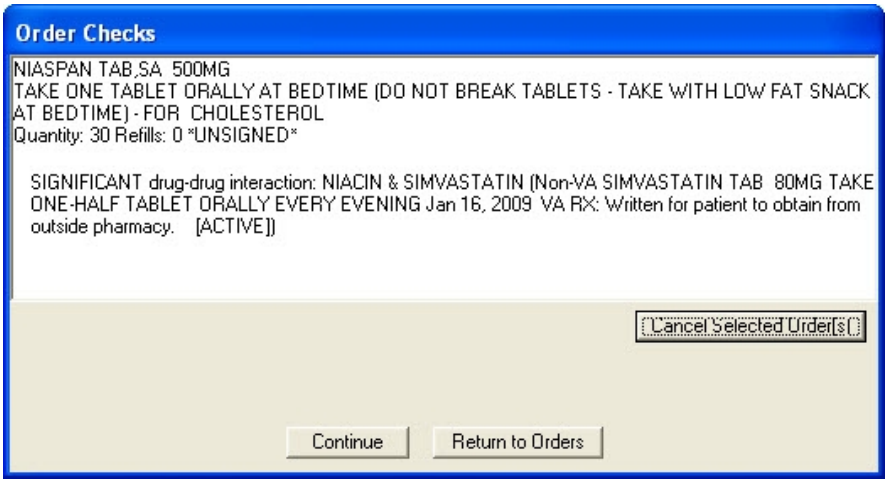

Figure 1. Illustrative example of a VA medication alert. Most alerts appear immediately after a medication has been selected; these alerts appear a second time in a summary pop-up window, like the one triggered above, when a prescriber attempts to electronically sign the order. A few alerts are tied to patient lab results and can appear before a prescriber selects a specific medication. The graphic above was generated by a fictitious medication order and does not contain actual patient data. Note that the information at the top of the pop-up refers to the current medication order while the information below pertains to the actual medication alert for a drug-drug interaction.

pharmacists. In the VA, these pharmacists do not dispense medications to patients; instead, they are physically integrated into each of the clinics; serve as a resource for non-pharmacy prescribers; and/or have prescribing privileges to help manage specific conditions, such as hypertension and dislypidemia. Physicians' assistants also have prescribing privileges in this VAMC, but there were no physicians' assistants in the primary care clinics at this facility, so they were not included in this study.

Study participants were recruited via e-mail, phone, or face-to-face, as well as through referral from another prescriber. We recruited 4 prescribers from each of the 5 primary care clinics. Prescribers' VA work experience ranged from < 1 yr to over 20 yrs with an average of 9 yrs. This variation is important because the VAMC transitioned to CPOE approximately 10 yrs ago. We observed prescribers as they ordered medications for patients via CPOE. Observations were approved by the Institutional Review Board (IRB) and scheduled for one half day per participant with an average observation length of 3.3 hrs. Observations were conducted by two independent researchers (AR, MM) between Aug 2008 and March 2009. During the observations, there were three questions that we asked each participant: 1) In what ways do medication alerts help with your work? 2) In what ways do medication alerts hinder your work? 3) If you could change the medication alerts, what, if anything, would you change? Furthermore, between patient encounters, we opportunistically asked other questions to clarify observations and gather additional information.

Observations were recorded via handwritten notes, typed, and then analyzed to identify emergent themes. These themes were identified via inductive qualitative analysis, without a pre-determined coding scheme.[8, 9] We used this methodology to identify themes across the observations. Some observations clearly related to two or more distinct themes and were double coded accordingly. One researcher (biomedical engineer) coded the transcripts with MAXQDA software and the analysis was guided by a pharmacist, practicing VA nephrology nurse practitioner, and human factors engineer. The diverse training of the research team strengthened the rigor of the analysis. This team met regularly, analyzed a sample of transcripts, and discussed potential new themes throughout the analysis until reaching consensus. A theme was designated as a barrier if it impeded medication alert use and diminished alert effectiveness in the context of clinical care, especially as it related to prescriber workflow and patient safety.

Results

Researchers observed 199 medication alerts across 66.5 hrs of observations and 91 patients. The analysis team identified 15 barriers for integrating medication alerts into prescriber workflow. These barriers are outlined in Table 1. Here, we present detailed results for five key barriers to prescriber

decision-making and clinical workflow, which relate to the style of alert display, alert content, and/or presentation of the alerts during medication ordering.

1. Poor Screen Display: During the observations, we found several examples where the style of the alert display was not sufficiently designed to aid prescribers' work. When discussing the alerts, a physician stated that "reading them is ugly". According to participants, alert displays were problematic since much of the alert text was in all capital letters (see Figure 1) and were also challenging when multiple alerts were grouped together in one pop-up window. There were several cases where a prescriber pointed out how a scroll box must be used to view multiple alerts. One physician stated, "When there's a lot of alerts there's a scroll down box…. If there's more than one [alert in a pop-up window], I don't read through them all, honestly."

2. Inadequate Alert Specification: In addition to the display style, at least three barriers related to insufficient alert content. One common finding was that alerts were not adequately specified and did not show all of the clinically-relevant information needed for prescriber decision-making. This was more problematic for non-pharmacy prescribers. One nurse practitioner said alerts need more "details about the interaction" and described how she tends to "pause longer on significant drug-drug interactions" and sometimes "pull[s] out [a] book to look it up". Physicians provided similar input. One physician said, "I wish it stated what the problem truly is, and simply. For example, simvastatin and diltiazem. [The alert] just says the drug names, not the problem….We call the pharmacist and spend time looking up information. If you have them [programmers] put the reason on there, it would be extremely helpful."

Pharmacists recognized the knowledge gap between alerts and non-pharmacist prescribers. A pharmacist explained that physicians often come and ask about an alert triggered by the combination of amiodarone and simvastatin: "The doctors don't know what the order check [alert] really means….If they had this information in CPRS it would decrease doctors' fear. The doctors would know more about it because it would provide more detail."

BARRIER	DESCRIPTION
1. Poor Screen Display	Alert display does not support alert resolution and/or prescriber workflow
2. Inadequate Alert Specification	Alert does not provide information on why it was triggered and/or the potential problem
3. Actual or Perceived Lack of Evidence	Alert is not evidence-based, does not provide a reference to evidence that does exist, and/or the actual or perceived level of evidence is low.
4. Unclear Level of Risk	Alert does not provide clear information on relative risk of harm for a given patient
5. Redundancy	Repeated alerts within the same encounter or over multiple encounters for a given patient
6. Low Alert Signal to Noise Ratio	Numerousness of alerts leads to information overload, prescriber desensitization, and potential for missing key alerts
7. Overuse of Pop-ups	Other, non-medication related pop-ups contribute to prescriber alert desensitization
8. Inadequate Allergy Logic	Alert system does not distinguish between true allergies and bothersome, but non-serious, side effects
9. Conflict with VA Policy/Care Practices	Alert conflicts with VAMC practices that are in place and/or standard medication practices
10. Duplicate Workload	Alert duplicates other required work processes
11. Order Entry Conflicts	System design does not match prescriber preferences for when or where medications are ordered, potentially compromising alert effectiveness
12. Paper Prescriptions & Limited CPOE	Some medications are not or cannot be entered electronically, and therefore, are not reviewed by the alert system
13. Unclear System Capabilities	Alert system does not adequately reveal its capabilities/limitations to the prescriber; full functionality of the alert system is ambiguous
14. Computer Delays	Computer downtimes, login problems, timeouts, etc. place prescriber under time pressure and interfere with alert examination
15. Supplies Included on Medication List	Supplies and medications are displayed together in CPRS and reduce the prescriber's ability to visually inspect the medication list for problems and resolve alerts.

Table 1. Analysis revealed 15 barriers to medication decision-making and prescriber workflow. In this document, the first five barriers are discussed in greater detail.

3. Actual or Perceived Lack of Evidence: Some prescribers were skeptical of alerts because it was unclear if the warnings were "evidence-based"; also, prescribers sometimes questioned the quality and strength of evidence. In one observation, a significant drug-drug interaction alert appeared for citalopram and tramadol. This interaction is evidence-based,[10] but the extent of evidence is fair, stemming mainly from a few case reports. Upon seeing this alert, the physician explained, "I prescribe these together a lot….I think the risk is theoretical..." Results also indicate that some medication alerts may *not* be supported by pharmacy data. One pharmacist stated, "Sometimes, a doctor will call me about an interaction. I check in Micromedex®. [Micromedex® is a well-respected medication interaction database.[10]] Sometimes, there is no interaction shown in Micromedex® [for that alert]. I tell the doctor, 'I don't know. There is no information on it in the [Micromedex®] database.'" The alerts themselves do not present the evidence nor do they provide links to any supporting documentation; at times, this lack of information led to prescriber cynicism.

4. Unclear Level of Risk: In addition to alert evidence, prescribers also wanted alerts to provide more information on the level of risk. Although some alerts are categorized by risk, (e.g., some are marked as "significant" and others are "critical"), this notation was not always sufficient for prescribers. One physician asked, "…can they quantify the risk? What makes an alert 'significant'? What's the difference between 'critical' and 'significant'?" In the same observation, the physician stated, "[It would be nice if alerts had] red, yellow, [and] green flags, where green is lower risk." Similarly, a pharmacist noted: "Also, some things say 'significant' but they are not really significant. Maybe they could have a rating of how significant things are."

5. Redundancy: During the observations, it was also apparent that alerts were sometimes excessively redundant. A nurse practitioner voiced her frustration with alerts: "[The alert system] is too repetitious …. [since] it pops up with the same thing so often, I click off of it by rote and may not see something that is different." In a different observation, a nurse practitioner ordered niacin and an alert was triggered by the combination of niacin and pravastatin. This same alert popped up again a few moments later when she went to sign the niacin order. It reappeared a third time when she ordered pravastatin and a fourth time when she went to sign the pravastatin order. The observer noted: *We have now seen the same alert 4 times in the last 10 min or less.* During a physician observation, three inhalers, albuterol, formoterol, and mometasone, triggered a set of three alerts that appeared four times in less than 20 min. The physician explained, "This is going to happen every time I order [these inhalers]. We have a lot of patients on multiple inhalers."

Discussion

Several studies have assessed medication alerts by investigating override databases and/or conducting surveys.[1-3, 7] This is one of the first studies to examine medication alerts during routine patient care. To enhance patient safety, medication alerts should be designed to support prescriber decision-making and clinical workflow. The results of this study demonstrate that there are many opportunities to improve the design of medication alerts for primary care prescribers in VAMCs.

There were several cases where inadequate alert design prompted prescribers to take extra steps in the medication ordering process and disrupted their workflow. For example, prescribers sometimes had to manipulate the alert to see all of the information; in other cases, this information was not sufficient, leading prescribers to seek out other resources. Prescribers described how they consulted databases and/or pharmacists to understand the meaning of the alerts and determine what actions to take.

In other instances, alerts were overly redundant and unnecessarily impeded medication ordering processes. In the VA, most medication alerts appear twice during the ordering process. This repeat appearance was probably created to add another layer of protection for patient safety. While this seems prudent, repeat alerts that do not aid prescriber decision-making place prescribers at risk for further desensitization and may actually weaken patient safety efforts. It may be possible to reduce the number of redundant and low-risk alerts to increase alert effectiveness and enhance patient care.

Medication alerts should not only warn prescribers about potential problems, but also provide enough information so they can be appropriately resolved. Study findings reveal several barriers to prescriber-decision making that relate to alert content. Ordering decisions were hampered by inadequate alert specification, actual or perceived lack of evidence for the alert, and unclear level of risk associated with the alert. These findings are supported in part by barriers associated with clinical practice guideline adherence,[11] and this lack of information has several potential consequences. Prescribers may become skeptical of the validity of the alert system, rely on their own assumptions about the alerts when pressed

for time, and/or overestimate or underestimate the potential adverse affects of the medication(s).

Results from this study may be used to develop alert redesigns that better support clinical workflow, prescriber decision-making and patient safety. Design strategies, ranging from simple to complex, may be used to improve medication alerts. Changing the style of the alert text alone may significantly enhance readability and alert utility. More complex changes for the alert content may help prescribers understand the meaning of the alerts and promote effective and efficient decision-making. Alerts may be improved through redesigns, which should be prototyped and then evaluated with usability testing.

Although this investigation revealed several key barriers associated with medication alerts, there are some limitations to consider when interpreting the results. This study was conducted at a large VAMC and barriers to workflow may not always be the same across medical centers, even though this alert system is used by VA prescribers throughout the Unites States. Furthermore, the VA alert system may have different strengths and weaknesses compared to non-VA systems despite evidence that VA and non-VA medication systems face similar design challenges.[1, 6, 7] Additional work is needed to assess barriers to medication alerts across different healthcare settings.

Conclusions

Medication alerts should be designed to aid clinical workflow and prescriber decision-making. Through this investigation, we identified several barriers to the use of medication alerts in the context of routine clinical care, many of which relate to aspects of the alert system design. In particular, it may be possible to facilitate medication ordering by improving the style and content of the medication alert display. Results can inform redesigns for usability testing and may ultimately be used to enhance medication prescribing and patient safety.

Acknowledgements

We would like to thank the study participants for their contribution to this investigation. This research was supported by the VA HSR&D Center of Excellence on Implementing Evidence-Based Practice, Center grant #HFP 04-148. Dr. Russ was funded by a VA HSR&D Associated Health Postdoctoral Fellowship; Drs. Zillich and Saleem were each supported by VA HSR&D Research Career Development Awards. Views expressed in this article are those of the authors and do not necessarily represent the views of the Department of Veterans Affairs.

References

1. Glassman PA, Belperio P, Simon B, Lanto A, Lee M. Exposure to automated drug alerts over time: effects on clinicians' knowledge and perceptions. Med Care. 2006 Mar;44(3):250-6.
2. Van der Sijs H, Aarts J, Vulto A, Berg M. Overriding of drug safety alerts in computerized physician order entry. J Am Med Inform Assoc. 2006 Mar-Apr;13(2):138-47.
3. Grizzle AJ, Mahmood MH, Ko Y, et al. Reasons provided by prescribers when overriding drug-drug interaction alerts. Am J Manag Care. 2007 Oct;13(10):573-8.
4. Weingart SN, Toth M, Sands DZ, Aronson MD, Davis RB, Phillips RS. Physicians' decisions to override computerized drug alerts in primary care. Arch Intern Med. 2003 Nov 24;163(21):2625-31.
5. Lin CP, Payne TH, Nichol WP, Hoey PJ, Anderson CL, Gennari JH. Evaluating Clinical Decision Support Systems: Monitoring CPOE Order Check Override Rates in the Department of Veterans Affairs' Computerized Patient Record System. J Am Med Inform Assoc. 2008 Sep-Oct;15(5):620-6.
6. Hsieh TC, Kuperman GJ, Jaggi T, et al. Characteristics and consequences of drug allergy alert overrides in a computerized physician order entry system. J Am Med Inform Assoc. 2004 Nov-Dec;11(6):482-91.
7. Ko Y, Abarca J, Malone DC, et al. Practitioners' views on computerized drug-drug interaction alerts in the VA system. J Am Med Inform Assoc. 2007 Jan-Feb;14(1):56-64.
8. Patterson ES, Cook RI, Render ML. Improving patient safety by identifying side effects from introducing bar coding in medication administration. J Am Med Inform Assoc. 2002 Sep-Oct;9(5):540-53.
9. Campbell EM, Sittig DF, Ash JS, Guappone KP, Dykstra RH. Types of unintended consequences related to computerized provider order entry. J Am Med Inform Assoc. 2006 Sep-Oct;13(5):547-56.
10. Micromedex® Healthcare Series. Thomson Micromedex, Greenwood Village, CO, USA. Available from: http://www.thomsonhc.com.
11. Cabana MD, Rand CS, Powe NR, et al. Why don't physicians follow clinical practice guidelines? A framework for improvement. JAMA. 1999 Oct 20;282(15):1458-65.